

REMARKS

This amendment is filed in response to the final Office Action dated May, 30 2003. Applicant submits that this application should be allowed and the case passed to issue.

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No new matter is raised by this amendment. Amended claim 2 is supported by claim 1. Claims 4, 5, 9, and 10 are amended to overcome rejections under 35 U.S.C. § 112. New claim 14 is supported by the Figures 2 and 3, which clearly show portions of the first region 2 that are not depleted by a depletion layer B extending from fourth region 7.

Claims 1-14 are pending in this application. Claims 1-6 and 9-11 are rejected. Claim 12 is objected to. Claims 7, 8, and 13 have been allowed. Claim 14 is newly added.

Claim Rejections Under 35 U.S.C. § 112

Claims 4 and 9 are rejected under 35 U.S.C. §112, first paragraph, as containing subject matter which is not described in the specification in such a way as to enable one skilled in the art to make and/or use the invention. This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

As regards claim 4, the Examiner asserts that the specification does not disclose the advantage of having the fourth region 7 electrically connected to the first electrode portion 8a. As regards claim 9, the Examiner avers that the specification does not disclose the advantage of having the fourth region 7 electrically connected to the second electrode portion 11.

Amended claim 4 corresponds to the fourth embodiment of the present invention. FIG. 22 clearly shows the second electrode 9 connected to the fourth region 7, as required by claim 4. Amended claim 9 corresponds to the sixth embodiment of the present invention. FIG. 26 and page 19, line 1 to page 20, line 13 of the specification, clearly
 OK discloses the fourth region 7 electrically connected to the first electrode 12. The rejection of claims 4 and 9 under 35 U.S.C. § 112, first paragraph, is clearly improper and should be withdrawn.

Claims 2, 5, 6, 10, and 11 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The Examiner asserts that it is unclear how a fifth region of the first conductivity surrounding the third electrode portion is formed at and near the surface of the first region, as in claim 2, when claim 1 requires that the third electrode portion is connected to a first region of a second conductivity type. As regards claim 5, the Examiner avers it is unclear how the position in depth of an interface between the first region and the fourth region changes in a direction crossing a direction of flow of current. The Examiner further asserts that it is unclear how the plurality of fourth regions have a depth changing as a position moves in a direction crossing a direction of flow of the current, as in claim 10. The Examiner considers independent claims 1 and 7 to be limited to a single fourth region. This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

Claims 2, 5, 10 are clear and definite. The ninth embodiment of the instant invention (page 22, lines 27-33 and FIG. 30) teach the fifth region of the first conductivity type surrounding the third electrode portion and formed at and near the surface of the first region, wherein said third electrode portion is connected to said fifth

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region, as required by claim 2. Although, FIG. 30 clearly teaches the third electrode 13 electrically connected to first region 2 via a pn junction between the fifth region 19 and the first region 2, in order to advance prosecution, amended claim 2 recites that the third electrode is connected to said fifth region.

As regards claims 5 and 10, the Examiner has improperly limited the scope of independent claims 1 and 7. There are no limitations in claims 1 and 7 that limit the scope of these claims to a single fourth region. Further, claims 1 and 7 use the transitional phrase "comprising." Thus, additional fourth regions are included within the scope of the claims. An Examiner is not to read non-existent limitations into a claim. The Examiner does not cite to any authority that permits such claim interpretation, nor is Applicant aware of any such authority. The Examiner's reading of additional limitations limiting the scope of claims 1 and 7 to a single fourth region is clearly erroneous.
not OK
However, in order to advance prosecution of this application, claim 5 has been amended to more precisely define its scope.

In addition, the Examiner's attention is directed to Applicant's response of March 10, 2003, where it was explained on page 9 (and illustrated in the attachments) how a position of an interface between the first region and the fourth region in a depth direction changing for any cross sections crossing a region in which the interface exists along a direction of flow of the current and substantially orthogonal to the direction of current flow for a fourth region comprising a plurality of discretely formed neighboring regions.

Claim 10 is objected to because the second occurrence of the word "connection" should be deleted. In response to this objection, claim 10 has been amended.

Claim Rejections Under 35 U.S.C. § 103

Claims 1, 3, and 4 are rejected under 35 U.S.C. §103(a) as being unpatentable over Kitamura et al. (US Patent No. 5,432,370). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested. The following is a comparison between the instant invention, as claimed, and the cited prior art.

An aspect of the invention, per claim 1, is a semiconductor device with a first region of a second conductivity type formed on and in direct contact with a semiconductor substrate of a first conductivity type. The semiconductor device further comprises a fourth region of the first conductivity type formed at and near the surface of the first region between a third electrode and a third region of the first conductivity type. An interface between the first region and the fourth region in a depth direction changes for any cross sections crossing a region in which the interface exists along a direction of flow of the current. In addition, the position of the interface in the depth direction also changes for any cross sections crossing the region along a direction substantially orthogonal to the direction of the current flow.

The Examiner avers that Kitamura substantially teaches the claimed semiconductor device and that it would have been obvious to have a fourth region with a position on the interface in the depth direction changing for any cross sections crossing the region along a direction substantially orthogonal to the direction of current flow because the impurity diffusion method of forming semiconductor regions is well known

and it produces curved pn junctions. In addition, the Examiner considers claim 3 inherent because the fourth region 4 of Kitamura is fixed to the source electrode 12a that is always connected to a constant source potential. As regards claim 4, the Examiner asserts that Kitamura discloses the fourth region 4 is electrically connected to the second electrode portion 12a.

In response to our arguments in the previous amendment, the Examiner asserts that Applicant cannot rely on the cross section Y'-Y' of sheet A attached to the March 10, 2003, response to interpret the limitations of claim 1. Kitamura, however, does not teach that the position of the interface between region 4 and region 2 changes for **any** cross sections crossing the region along a direction substantially orthogonal to the direction of the current flow, as required by claim 1. As shown in attached sheet A of the March 10, 2003 response, along line Y-Y a position of the interface between region 4 and region 2 in the depth direction changes for crossing the region along a direction substantially orthogonal to the direction of the current flow. However, line Y'-Y' clearly illustrates
OK that not **any** position of the interface in the depth direction changes for a cross section
crossing along the region substantially orthogonal to the direction of the current flow in
the device of Kitamura. As shown in Fig. 6(a) of Kitamura, openings 36 do not extend
across the entire width of region 4. Thus, the device of Kitamura includes a portion in
OK which a position of an interface between region 4 and region 2 in the depth direction is
constant, as shown by line Y'-Y'.

As explained in the March 10, 2003 response, Kitamura does not suggest the claimed semiconductor device. In Kitamura region 4 is formed over most of the region between the source and drain to ensure a high withstand voltage due to a JFET effect. In

addition, an opening 36 is formed in region 4 above region 2 to substantially increase a cross section of region 2 to decrease the on resistance (column 11, lines 3-6).

In contrast to the Kitamura device, the present invention does not ensure a high withstand voltage due to a JFET effect. The interface between first region 2 and fourth region 7 exists in the cross-hatched regions show in marked up Fig. 1 of sheet B attached to the March 10, 2003 response, and marked up Fig. 14 of sheet C, attached to the March 10, 2003 response. Fourth region 7 only contributes to reduce the electric field in a portion in which it is located.

not true
not true
In the region in which the interface between first region 2 and fourth region 7 exists, a position of the interface in a depth direction changes for any cross sections crossing the region along a direction of the current flow (thick arrow). In addition, the position of the interface in the depth direction also changes for any cross sections crossing the region along a direction substantially orthogonal to the direction of the current flow (thin arrow).

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It is noted that, if region 4 (fourth region) and region 2 (first region) as shown in the Y'-Y' cross section of Kitamura are formed in the present invention, the structure will be similar to that shown in Prior Art Fig. 31, and the resistance will increase. Such a structure would not provide the benefits of the present invention and would not read on the instant claims.

The instant claims are further distinguishable over Kitamura because Kitamura essentially describe that a depletion layer is extended from the fourth region 4 sandwiched by exposed portions 36 to attain a pinch-off state (column 11, line 8 *et seq.*).

In the present invention, however, as shown in FIG. 2, depletion layers A, B extend in the first region 2 in an on state. The depletion layers are formed such that they differ in position (depth) of the ends thereof so as to guarantee the current flow and to suppress the resistance in the on state. As a result, the present invention does not perform a pinch-off operation in which the first region 1 would be entirely depleted to suppress the current flow. The first region 2 has a region, located directly beneath the depletion layer B, that is not depleted by the depletion layer B which extends from the fourth region 7 in the one state, as show in Figs. 2 and 3.

Furthermore, in Kitamura, the depletion of the fourth region 4 is such that the withstand voltage is not restricted between the n+ diffusion layer 9 and the p-diffusion layer fourth region 4 in an off state. In addition, the fourth region 4 should be electrically connected to the electrode 12a to ensure stability of the pinch-off operation. In the present invention, in contrast to Kitamura, the extension of the depletion layer alleviates the electric field, so that the fourth region is allowed to function sufficiently even if it is in an electrically floating state.

Allowable Subject Matter

Claim 2 would be allowable if rewritten in independent form and to overcome the rejection under 35 U.S.C. § 112. Claim 2 has been rewritten in independent form and to overcome the rejection under 35 U.S.C. § 112, therefore, claim 2 should be allowed, as explained above.

Claim 12 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form.

Claims 7, 8, and 13 are allowed.

Applicant gratefully acknowledges the indication of allowable subject matter.

Applicant submits that it is not necessary to place claim 12 in independent form, as claim 1 is allowable as explained above.

In light of the amendment and remarks above, this application should be allowed and the case should be passed to issue. If there are any question regarding this Amendment or the application in general, a telephone call to the undersigned would be appreciated to expedite the prosecution of the application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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